

Lesson Plan

Scientific Study

Book: *Voyage to Pluto*

Series: Destination Space

Level: Voyager

Objective

To help students analyze how the technology used by the *New Horizons* probe contributed to the mission's discoveries about Pluto and other objects in space.

Supplies

- *Voyage to Pluto*
- Scientific Study Guided Reading Assignment (attached)
- Paper and pencils

Before the Activity

Have students read *Voyage to Pluto*. Divide students into five groups. Print the Scientific Study GRA and cut it apart so each group's questions are on a separate slip of paper. If you prefer smaller groups, print two copies of the Scientific Study GRA and divide students into 10 groups.

Activity

An important part of the New Horizons mission was the vast amount of scientific information that the probe gathered about Pluto. This information was collected by the probe's scientific instruments. Today, students will take a closer look at the technology that made this journey possible.

Divide students into their groups, giving each group a list of questions. Students in each group should work together to answer the questions. They should write their answers on a separate sheet of paper. After giving groups several minutes to write their answers, ask the questions to the entire class. Call on students who studied each question in their group to read their answer out loud. After students have answered all the questions, collect the written answers from each group.

Evaluation

Using the attached answer key, give students in each group up to 8 points for their answers.

Standards

This lesson may be used to address the Common Core State Standards' reading informational texts standards, grade 6 (RI 6.3) and the National Science Education Standards' Content Standards D and E, grades 5–8.

Scientific Study GRA

Group 1: Testing and Design

1. The New Horizons mission was officially approved in the spring of 2003. What did scientists work on for the next two and a half years? (2 points)
2. *New Horizons* lifted off on January 19, 2006. How did the probe's design help it begin its journey successfully? (2 points)
3. In June 2006, *New Horizons* reached the asteroid belt. What tests did scientists do at this point of the probe's journey? (2 points)
4. In February 2007, *New Horizons* flew past Jupiter. What tests did scientists do at this point of the probe's journey? (2 points)

Group 2: Scientific Instruments

1. *New Horizons* had seven scientific instruments. What kinds of information did these instruments collect? (2 points)
2. What was the name and function of each instrument? (4 points)
3. The probe's two cameras snapped photos throughout the journey to Pluto. What kind of photos did they take? (2 points)

Group 3: Closest Approach

1. On July 14, 2015, *New Horizons* made its closest approach to Pluto and took hundreds of photos. What did these images reveal about the dwarf planet's surface? (3 points)
2. During its closest approach, *New Horizons* was traveling 8.6 miles (14 km) per second. Why weren't the photos it took blurry? (3 points)
3. Compared to Earth, far less sunlight reaches Pluto. How were the probe's cameras designed for these conditions? (2 points)

Group 4: Pluto's Atmosphere

1. Scientists used *New Horizons* to study Pluto's atmosphere. What did the probe's cameras help them learn? (2 points)
2. The probe's scientific instruments collected data about Pluto's atmosphere as well. What kind of things did they measure? (4 points)
3. An instrument called REX picked up radio waves sent out by giant antennas on Earth. Why was this important? (2 points)

Group 5: After Pluto

1. *New Horizons* studied Pluto's moons. Four of the moons were too small for the probe's cameras to see in detail. What information were scientists able to collect about these moons? (2 points)
2. What were the probe's cameras able to observe about Charon and its surface? What made that possible? (2 points)
3. *New Horizons* flew past Pluto without orbiting. What would it take for a spacecraft to orbit Pluto? (2 points)
4. After *New Horizons* passed Pluto, scientists planned for it to study another object in the Kuiper Belt. What information would *New Horizons* help scientists learn about this object? (2 points)

Scientific Study GRA Answer Key

Group 1: Testing and Design

1. The New Horizons mission was officially approved in the spring of 2003. What did scientists work on for the next two and a half years? (2 points)

“For the next two and a half years, scientists working on the *New Horizons* project were very busy. They had to make sure the expensive spacecraft could survive the long journey from Earth to Pluto. In addition, they had to test the spacecraft’s cameras and other instruments. Pluto orbits the sun in the cold depths of the solar system, so scientists had to make sure the instruments would work in such chilly conditions” (pp. 7–8).

2. *New Horizons* lifted off on January 19, 2006. How did the probe’s design help it begin its journey successfully? (2 points)

“At approximately 1,000 pounds (454 kg), *New Horizons* was relatively light for a spacecraft. But it was launched by a powerful rocket. This combination allowed the spacecraft to lift off very quickly. In fact, *New Horizons* had the fastest launch in history. When the probe zoomed away from Earth on January 19, 2006, it was moving more than 36,000 miles per hour (57,900 km/h)” (pp. 8–9).

3. In June 2006, *New Horizons* reached the asteroid belt. What tests did scientists do at this point of the probe’s journey? (2 points)

“*New Horizons* flew past one asteroid that was the size of a mountain. As the probe passed this asteroid, scientists tested one of its cameras. They also tested the technology the spacecraft used to track its target” (p. 15).

4. In February 2007, *New Horizons* flew past Jupiter. What tests did scientists do at this point of the probe’s journey? (2 points)

“Scientists used this flyby to test the probe’s scientific instruments. *New Horizons* took photos of Jupiter and its moons as well. . . . Other instruments recorded the types of chemicals in Jupiter’s atmosphere. These tests helped scientists make sure the spacecraft’s scientific instruments were working properly” (pp. 15–16).

Group 2: Scientific Instruments

1. *New Horizons* had seven scientific instruments. What kinds of information did these instruments collect? (2 points)

“The instruments did many things. Cameras snapped photographs throughout the journey to Pluto. Other instruments collected data about Pluto’s chemistry and environment. They recorded information about the dwarf planet’s atmosphere. An antenna sent this information back to Earth” (pp. 14–15).

2. What was the name and function of each instrument? (4 points)

PEPSSI measured the particles that escaped from Pluto’s atmosphere.

SWAP measured the solar wind around Pluto and how Pluto interacted with it.

LORRI used a telescope and camera to study Pluto from a long distance and to provide

detailed images of its surface.

SDC measured the space dust that hit *New Horizons* as it traveled through space.

Ralph used visible light and infrared light to make colored maps and thermal maps of Pluto's surface.

Alice used ultraviolet light to study the composition of Pluto's atmosphere and search for atmospheres around other objects.

REX picked up radio waves sent out by giant antennas on Earth to study Pluto's atmosphere. ("How *New Horizons* Studied Pluto" infographic, p. 14)

3. The probe's two cameras snapped photos throughout the journey to Pluto. What kind of photos did they take? (2 points)

"*New Horizons* uses two cameras. One camera takes only black-and-white photos. The second camera can detect many kinds of light. Its eight parts get information from one telescope. Three parts pick up black-and-white light. Other parts can detect color or infrared light" (pp. 24–25).

Group 3: Closest Approach

1. On July 14, 2015, *New Horizons* made its closest approach to Pluto and took hundreds of photos. What did these images reveal about the dwarf planet's surface? (3 points)

"Scientists were surprised to find areas on Pluto with few or no craters. One area is the size of Texas. The material in this frozen plain may be only 10 million years old. That is very young compared with the rest of the solar system. Second, the pictures showed large amounts of water ice. The ice had recently flowed in the same way that glaciers move on Earth's surface. The pictures showed Pluto even has ice mountains that are as tall as the Appalachian Mountains in the United States. The dwarf planet may also have volcanoes that spew slush instead of hot lava" (p. 23).

2. During its closest approach, *New Horizons* was traveling 8.6 miles (14 km) per second. Why weren't the photos it took blurry? (3 points)

"[The] spacecraft was still very far from Pluto. Suppose a person is flying in an airplane. She sees a mountain off in the distance. The airplane is traveling 600 miles per hour (966 km/h). That is approximately 10 miles (16 km) each minute. But the person is much farther than 10 miles (16 km) from the mountain. As a result, the mountain appears to stay in the same place, and she can still take an unblurred photo of it" (pp. 24–25).

3. Compared to Earth, far less sunlight reaches Pluto. How were the probe's cameras designed for these conditions? (2 points)

"Like any spacecraft that travels far from the sun, *New Horizons* uses a special type of camera. The camera's large aperture lets in as much light as possible. This allows the camera to take pictures even in very low light" (pp. 24–25).

Group 4: Pluto's Atmosphere

1. Scientists used *New Horizons* to study Pluto's atmosphere. What did the probe's cameras help them learn? (2 points)

“The probe snapped a photo as it flew through Pluto's shadow. The photo showed how sunlight passes through the dwarf planet's atmosphere. It revealed that the atmosphere is made of multiple layers” (p. 27).

2. The probe's scientific instruments collected data about Pluto's atmosphere as well. What kind of things did they measure? (4 points)

"They studied the atmosphere's pressure and temperature. They also revealed what the atmosphere was made of. For example, one instrument detected molecules such as methane and carbon monoxide" (pp. 27–28).

"Another instrument watched as radio waves sent from Earth passed through Pluto's atmosphere. A third instrument measured how quickly gases in the atmosphere evaporated and escaped into space. It also looked at how the sun's radiation affects Pluto" (p. 29).

3. An instrument called REX picked up radio waves sent out by giant antennas on Earth. Why was this important? (2 points)

"[REX] watched as radio waves sent from Earth passed through Pluto's atmosphere. This was a big achievement. In the past, spacecraft could only broadcast radio signals, which would then be detected by instruments on Earth. But *New Horizons* picked up signals that were sent from Earth. This new experiment allowed the spacecraft to measure the pressure of the gas in Pluto's atmosphere" (p. 29).

Group 5: After Pluto

1. *New Horizons* studied Pluto's moons. Four of the moons were too small for the probe's cameras to see in detail. What information were scientists able to collect about these moons? (2 points)

"Still, scientists measured the moons' sizes. They also measured how bright the moons are. By combining data about each moon's size and brightness, scientists could guess how dense the moon is. They counted craters on each moon's surface to estimate how old the moon might be" (p. 32).

2. What were the probe's cameras able to observe about Charon and its surface? What made that possible? (2 points)

"Because Charon is much bigger than Pluto's other moons, the spacecraft's cameras could make out more details on its surface. Photos showed a deep canyon stretching across the moon's full width. Scientists think this canyon is 1,100 miles (1,800 km) long. It may be 4.5 miles (7.5 km) deep. Cliffs and ridges stretch hundreds of miles across Charon's surface" (p. 32). "Images of Charon also show a large red patch near its northern pole" (p. 34).

3. *New Horizons* flew past Pluto without orbiting. What would it take for a spacecraft to orbit Pluto? (2 points)

“To go into orbit, a spacecraft would have to lose energy as it neared Pluto. But Pluto’s gravity alone is too weak to slow a spacecraft enough. Instead, the spacecraft would need to use a rocket to slow itself down. The spacecraft would have to carry this extra rocket all the way to Pluto. It would need to bring extra fuel, too. Once the spacecraft reached Pluto, the rocket would use this extra fuel. Firing the rocket many times would keep the spacecraft from shooting past Pluto. Then the spacecraft could go into orbit” (pp. 43–44).

4. After *New Horizons* passed Pluto, scientists planned for it to study another object in the Kuiper Belt. What information would *New Horizons* help scientists learn about this object? (2 points)

“Like it did for Pluto, *New Horizons* would take pictures of the object and map its chemical content. Scientists could try to determine if the object had moons or rings. They could learn about the region around the object as well” (p. 39).